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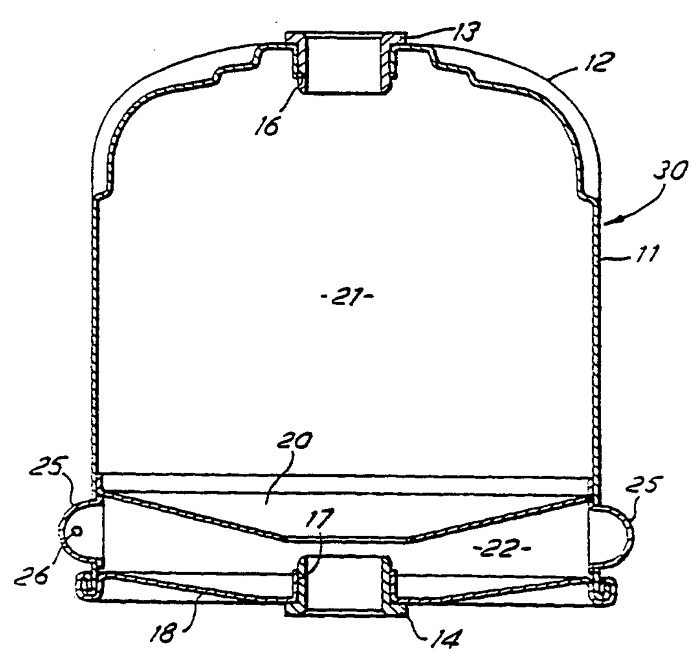
(57) Abstract

A rotor (10) for a centrifugal separator, comprising bearing means (13, 14) for mounting the rotor for rotation about a substantially vertical axis in such a way that fluid to be treated can be supplied through the bearing means (13, 14) to the interior of the rotor (10), and at least one nozzle (25) provided on the periphery of the rotor in the region of its lower end such that the reaction force caused by fluid discharged through the nozzle (25) serves to spin the rotor (10) about the substantially vertical axis. The provision of the nozzle (25) on the rotor periphery (11), inter alia, provides increased torque because the nozzle is at a maximum distance from the rotary axis. According to other aspects of the invention, the rotor has three or more nozzles (either in the base or in the periphery) and nozzles are provided at different distances from the rotary axis, the outer nozzles pr viding incrased torque particularly for start-up.



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Rotors for Centrifugal Separators

This invention relates to rotors for centrifugal separators, particularly centrifugal separators for use as fuel or lubricating oil cleaners for engines and transmission units such as internal combustion engines and gearboxes. The invention extends to separators employing such rotors.

Centrifugal separator rotors of this type are normally rotatably mounted on a vertical shaft through which oil is introduced into the rotor and driven by the reaction force arising when oil under pressure leaves tangentially directed nozzles or jets at the bottom of the rotor. We have found that the ability of the nozzles to rotate the rotor at high speed is impaired if the oil flow through the nozzles is turbulent and this effectively limits the use of higher pressures within the rotor to achieve higher speeds and therefore more efficient separation. Heretofore it has been usual to provide the nozzle opening in a side of a hollow round projection which extends downwards from the base of the rotor and which is open to the interior of the rotor at its upper end and closed at its lower end. The projection may take the form of an upwardly open, generally hemispherical member with a nozzle opening at one side. The member is for example flanged at its upper end so that the projecting piece can be passed through a hole in the base of the rotor until the flange rests on the periphery of the hole and can be secured in position e.g. by soldering, brazing or welding. However, particularly in the case of disposable sheet metal rotors such as those described in US Patent 4,106,689, the projection may be pressed out of the base wall of the rotor and is accordingly integral with the rotor. The nozzle opening may be simply a hole in the projection or it may be provided by a jet member screwed or forced into the hole. Normally there are two or more nozzles in a symmetrical arrangement.

According to one aspect of the invention, a rotor for a centrifugal separator has at least one nozzl provided on its peripheral wall through which liquid leaves the rotor in a direction so as to produce a

reaction force which spins the rotor. Such an arrangement has been found to provide increased torque over more conventional arrangements with nozzles in the base of the rotor. This is particularly significant at start-up since the rotor begins to rotate at a lower oil pressure.

Preferably the nozzle is provided in a projection in the rotor wall, the projection providing an inclined lead-in or trough for liquid approaching the nozzle hole such that a substantial change of direction of the liquid flow adjacent the nozzle opening is avoided. We have found that such an arrangement permits substantially greater liquid flow rates without turbulence, thus increasing the rotor speed. Furthermore such an external projection shape has a stream-lining effect which reduces air resistance and it permits a nozzle of accurate size and direction to be made in the projection wall thus, in some cases, avoiding the need for a separate jet member. Preferably the nozzle holes are punched in the projections by a piercing operation from the inside of the trough during a stage of the forming operation. It is important that no 'rag edges' or burrs are left on the inside of the nozzle as this may increase turbulence and thus impair the performance of the rotor. Alternatively drilled nozzles may be employed but again these are preferably drilled from the inside so that any burrs are on the outside of the nozzle. The provision of nozzles in troughs of increasing depth is described in European Patent Application No. 86101359.7 and US Patent Application No. 833592 of Ronald James Purvey to which the reader's attention is directed for more details of the preferred ways of putting this feature of the invention into practice.

According to another aspect of the invention, a rotor for a centrifugal separator has at least one nozzle spaced a first radial distance from the axis of rotation and at least one nozzle spaced a second, greater, radial distance from the axis of rotation, such that liquid leaving the nozzles produces a reaction force which spins the rotor. With such an arrangement the liquid pressure at the outer nozzle is higher than the liquid pressure at the inner nozzle due to centrifugal force, the difference in pressure increasing with the speed of rotation of th rotor. Thus, it can be arrang d that the outer nozzle is effective to produce a non-turbulent

flow under low speed start-up conditions but becomes less effective due to turbulence at high speeds when the inner nozzle takes over.

According to another aspect of the invention, a rotor for a centrifugal separator has three or more nozzles through which liquid leaves the rotor in a direction so as to produce a reaction force which spins the rotor.

Two or more of the various novel aspects of the invention may be combined in a single rotor and generally at least two nozzles are provided.

A rotor for a centrifugal oil separator should be able to withstand transient pressures of up to 20 bar during cold start-up conditions. The rotor must, therefore, be able to withstand such pressures without permanent distortion. Any substantial distortion tends to jam the rotor and prevent rotation.

Desirably the rotor includes a cover member, an inner flow directing and debris-retaining member and a base member which are all produced from thin sheet metal pressings.

Preferably, the nozzles are formed such that the direction of the issuing oil jet is directed at an angle downwardly away from the rotor to prevent oil splash-back from the housing in which the rotor rotates from reaching and thus slowing the rotor.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 is a section through a first embodiment of a rotor for a centrifugal oil cleaner in the form of a disposable cartridge;

Fig. 2 is an underneath plan view of the rotor of Fig. 1;

Fig. 3 shows a modification of Fig. 2 in which three symmetrically arranged nozzles are provided;

Fig. 4 shows a modification of Fig. 2 in which four symmetrically arranged nozzles are provided;

Figs. 5-8 show modifications of Figs. 1-4 respectively showing a different way of providing the nozzles;

Fig. 9 is a section through a second embodiment of a rotor for

a centrifugal oil cleaner in the form of a disposable cartridge;

Fig. 10 shows an underneath plan view of the rotor of Fig. 9;

Fig. 11 shows a modification of Fig. 10 with three symmetrically arranged nozzles;

Fig. 12 shows a modification of Fig. 10 with four symmetrically arranged nozzles, in which one pair of nozzles is at one radius and the other pair of nozzles is at another radius;

Figs. 13-16 show modifications of Figs. 9-12 respectively showing a different way of providing the nozzles;

Fig. 17 shows a modification of Fig. 5 in which a pair of nozzles similar to those in Fig. 5 are also provided in the base;

Fig. 18 shows a modification of Fig. 13 in which a reinforcing tube is provided; and

Fig. 19 shows a centrifugal separator in the form of an oil cleaner with the rotor of Fig. 18 mounted therein.

The rotor 10 shown in Figs. 1 and 2 comprises a pressed cylindrical cover member 11 with radial strengthening corrugations 12 in a domed portion at the top. Flanged metal bearing bushes 13, 14 are lodged in aligned openings 16, 17 at the top of the casing 11 and in a base plate 18 permanently secured to the casing 11 at its periphery by a roll-over joint. A flanged annular dividing wall or baffle 20 is secured to the cover member 11 e.g. by soldering, welding or brazing, to provide a centrifuging chamber 21 and a nozzle chamber 22 communicating adjacent the rotary axis; the wall 20 thus provides an inner flow directing and debris-retaining member and, like the base plate 18, it is dished. Two diametrically opposed nozzles 25 are provided in apertures in the lower region of the periphery of the cover member 11. In this embodiment the nozzle 25 comprise units of flanged hemispherical shape which are secured in the apertures e.g. by soldering, welding or brazing and which have discharge holes 26. Such nozzle units are well known in the art. As shown the nozzles 25 direct the oil horizontally and slightly outwardly from the tangential direction, but as mentioned above it may b desirable to direct the oil more downwardly.

Fig. 3 shows an arrangement with three nozzles 25 and Fig. 4 shows an arrangement with four nozzles 25; in each case the nozzles are symmetrically arranged.

Figs. 5-8 show a modification of Figs. 1-4 in which the nozzles 25 each comprise a projection pressed out of the cover member 11 and providing a smoothly contoured circumferential trough of deepening section starting with minimum depth at the beginning of the trough remote from the nozzle hole 26 and finishing with maximum depth adjacent the nozzle hole 26.

The arrangement shown in Figs. 9 and 10 is similar to that shown in Figs. 1 and 2 except that there are four symmetrically arranged nozzles 25 which are provided in the base plate 18 rather than in the cover member 11. Increasing the number of nozzles in this way increases the turning torque and the rate of oil flow through the separator. In Fig. 11 there are only three nozzles 25.

In Fig. 12, there are a pair of diametrically opposed inner nozzles 28 and a pair of diametrically opposed outer nozzles 29. As explained above, the outer nozzles provide a good starting torque but as the speed builds up the flow through them may become turbulent due to the increasing pressure arising from centrifugal force so that the inner nozzles effectively take over the driving function. It will be appreciated that further nozzles may be provided in the base plate 18 in Figs. 1-8 so that the peripheral wall nozzles act as start-up nozzles in the manner of Fig. 12; one such arrangement is shown in Fig. 17.

Figs. 13-16 show a modification of Figs. 9-12 in which the nozzles 25 each comprise a projection pressed out of the base plate 18 in the manner of Figs. 5-8.

The projections which form the nozzles may conveniently be as described in European Patent Application No. 86101359.7 and US Patent Application No. 833592 of Ronald James Purvey. As described in these earlier applications the nozzle hol s 26 are formed by drilling from the inside so that any burrs are on the outsid . As explained in the earlier applications, the projections which form the troughs reduce air resistance

to rotation and the troughs reduce turbulence in the oil flow.

Fig. 17 shows an arrangement in which there are a first pair of nozzles 25 in the cover member 11 and a second pair of nozzles 25 in the base plate 18. The four nozzles act in the same way as the nozzles 28, 29 of Fig. 16 and are preferably disposed symmetrically as in Fig. 16.

Figs. 18 and 19 show both how the rotors of Figs. 1-16 may be modified by the incorporation of a reinforcing tube which acts as a tension member and how they may be mounted in a centrifugal oil cleaner.

As shown in Fig. 18 a tubular tension member 40 is disposed between the cover member 11 and the base plate 18. The tubular member 40 has an outwardly turned flange 41 at its lower end such that the flange 41 is outside and supportive of the base plate 18 and a second outwardly turned flange 42 at its upper end again outside and supportive of the cover member 11. The tubular tension member 40 is a press-fit in the two flanged holes 16 and 17 in the cover member 11 and base plate 18 respectively. In the upper portion of the member 40 are oil entry holes 43. The bearings 13 and 14 are press-fitted directly into the tubular member 40 which is coaxial with the rotor axis 33. An annular opening 44 is defined by the member 20 and the tension member 40. The tubular member 40 serves to both resist tensile stresses resulting from high oil pressures which tends to expand the cartridge both radially and axially. Furthermore the tubular member also provides a repeatable datum in which to insert the bearings 13 and 14 and to maintain axial alignment even at high oil pressures.

Fig. 19 shows the rotor of Fig. 18 in a centrifugal separator housing. The housing comprises a body member 50. At the body 50 upper end there is a rebated lip 51 to receive and locate a rubber sealing ring 52. At the body 50 lower end there is a tapered portion 53. Within the body 50 a cruciform sheet metal structure 54 (in plan view the frustoconical part has four large arcuate openings) is spot-welded to the body 50 and supports a vertical shaft 55 by a bolt 56. Located between shaft 55 and bolt 56 is a bush 65, the upp r face 66 of which provides a

thrust surface. The shaft 55 has at its upper end a male threaded portion 57 which co-operates with a female threaded portion 58 in, for example, a support housing 59 on an engine cylinder block (not shown). Part of the upper end of the shaft 55 is drilled axially with a conduit 60 which also comprises a cross drilling 61 opening out into the tubular member 40 of the rotor. The shaft 55 and tubular member 40 define a cylindrical annulus 62. Oil is supplied to the conduit 60 via a passage 63 formed in the housing 59. The body 50 and cartridge are secured to the housing 59 by screwing the complete body 50 on to the housing 59 by the co-operating threads 57 and 58, the sealing ring 52 being compressed into the rebated lip 51 and sealing against the face 64 of the housing 59.

In steady state operation oil under a pressure of about 5 bar flows through the passage 63, into the conduit 60 and out of the cross drilling 61. The annulus 62 fills with oil and then flows through the oil entry holes 43 into the chamber 21 of the cartridge formed between the base 18, the cover member 11 and the tubular member 40. When the chamber 21 is full, oil is ejected under pressure from the nozzles 25 thus causing the rotor to rotate by a reaction force, the rotor being supported on the shaft 55 by the bearings 13 and 14. The top face of the bush 65 provides a thrust face for the bearing 14. The ejected oil flows down the inner walls of the body 50 through the restriction 53 where it drains away to an oil sump or tank (not shown).

The direction of rotation of the rotor is preferably such that the oil drag produced on the body 50 tends to tighten the body on the co-operating screw threads 57 and 58. Thus in Fig. 19 where threads 57 and 58 are right-hand threads the direction of rotation of the cartridge will be clockwise when viewed from below.

Although the nozzles shown in Figs. 1-8 are in the lower part of the cover member, it is of course possible to locate the joint joining the cover member and the base member higher up the rotor so that the nozzles are in an upstanding wall of the base member (or even in an intermediate cylindrical member interconnecting a cover and a base).

CLAIMS

1. A rotor for a centrifugal separator, comprising bearing means for mounting the rotor for rotation about a substantially vertical axis in such a way that fluid to be treated can be supplied through the bearing means to the interior of the rotor, and at least one nozzle provided on th periphery of the rotor in the region of its lower end such that the reaction force caused by fluid discharged through the nozzle serves to spin the rotor about the substantially vertical axis.

2. A rotor according to claim 1, which is in the form of a disposable cartridge comprising a cover member, an inner flow directing and debris-retaining member, and a base member, the cover member being connected to the periphery of the base member at its lower end to provide a generally cylindrical lower region, the inner flow directing and debris retaining member providing a baffle extending inwards from the wall of the cover member in the lower region thereof but above the nozzle, and the bearing means comprising bearings in the base member and in the upper part of the cover member.

3. A rotor according to claim 2, wherein the cover member is in the form of a dome with a depending cylindrical skirt.

4. A rotor according to claim 2 or 3, wherein the cover member is in the form of a metal pressing with radial reinforcements at its upper end.

5. A rotor according to claim 2, 3 or 4, wherein the cover member is in the form of a metal pressing and the nozzle is provided in a projection pressed out of it.

6. A rotor according to claim 5, wherein the projection provides a smoothly contoured circumferential trough of deepening section starting

with minimum depth at the beginning of the trough remote from the nozzle and finishing with maximum depth adjacent the nozzle.

7. A rotor according to claim 6, wherein the nozzle is formed integrally with the projection.

8. A rotor according to claim 7, wherein the nozzle is pierced from the inside of the trough.

9. A rotor according to any one of claims 1-6, wherein the nozzle is provided by a flanged nozzle member secured to the rotor.

10. A rotor according to any one of claims 1-9, wherein at least two nozzles are provided, the nozzles being symmetrically disposed around the rotor.

11. A rotor according to claim 10, wherein there are two nozzles.

12. A rotor according to claim 10, wherein there are three nozzles.

13. A rotor according to claim 10, wherein there are four nozzles.

14. A rotor according to claim 1, which is in the form of a disposable cartridge of pressed metal provided with at least two nozzles and deflector means above the nozzles in the interior of the cartridge and providing a fluid discharge chamber in the lower part of the cartridge.

15. A rotor for a centrifugal separator, comprising bearing means for mounting the rotor for rotation about a substantially vertical axis in such a way that fluid to be treated can be supplied through the bearing means to the interior of the rotor, and at least three nozzles provided in the lower end region of the rotor such that the reaction force caused by

fluid discharged through the nozzles serves to spin the rotor about the substantially vertical axis.

16. A rotor for a centrifugal separator, comprising bearing means for mounting the rotor for rotation about a substantially vertical axis in such a way that fluid to be treated can be supplied through the bearing means to the interior of the rotor, and nozzles provided in the lower region of the rotor, at least one nozzle being spaced a first radial distance from the axis of rotation and at least one nozzle being spaced a second, greater, radial distance from the axis of rotation, such that the reaction force caused by fluid discharged through the nozzles serves to spin the rotor about the substantially vertical axis.

17. A rotor according to claim 16, wherein there are at least two nozzles at the first radial distance and at least two nozzles at the second radial distance.

18. A rotor according to any one of claims 15-17, which is in the form of a pressed metal disposable cartridge.

19. A rotor according to any one of claims 15-18, wherein the nozzle or nozzles is in the base of the rotor.

20. A rotor according to any one of claims 14-19, which comprises a cover member secured to a base member, wherein the cover member is in the form of a dome with a depending cylindrical skirt.

21. A rotor according to claim 20, wherein the cover member is in the form of a metal pressing with radial reinforcement ribs at its upper end.

22. A rotor according to any one of claims 14-21, wherein the or each nozzle is provided in a pressed-out projection and the or each

projection provides a smoothly contoured circumferential trough of deepening section starting with minimum depth at the beginning of the trough remote from the nozzle and finishing with maximum depth adjacent the nozzle.

23. A rotor according to any one of claims 1-14, which comprises at least one further nozzle in the lower face of the rotor.

24. A centrifugal separator for cleaning oil or fuel, comprising a housing and a rotor according to any preceding claim.

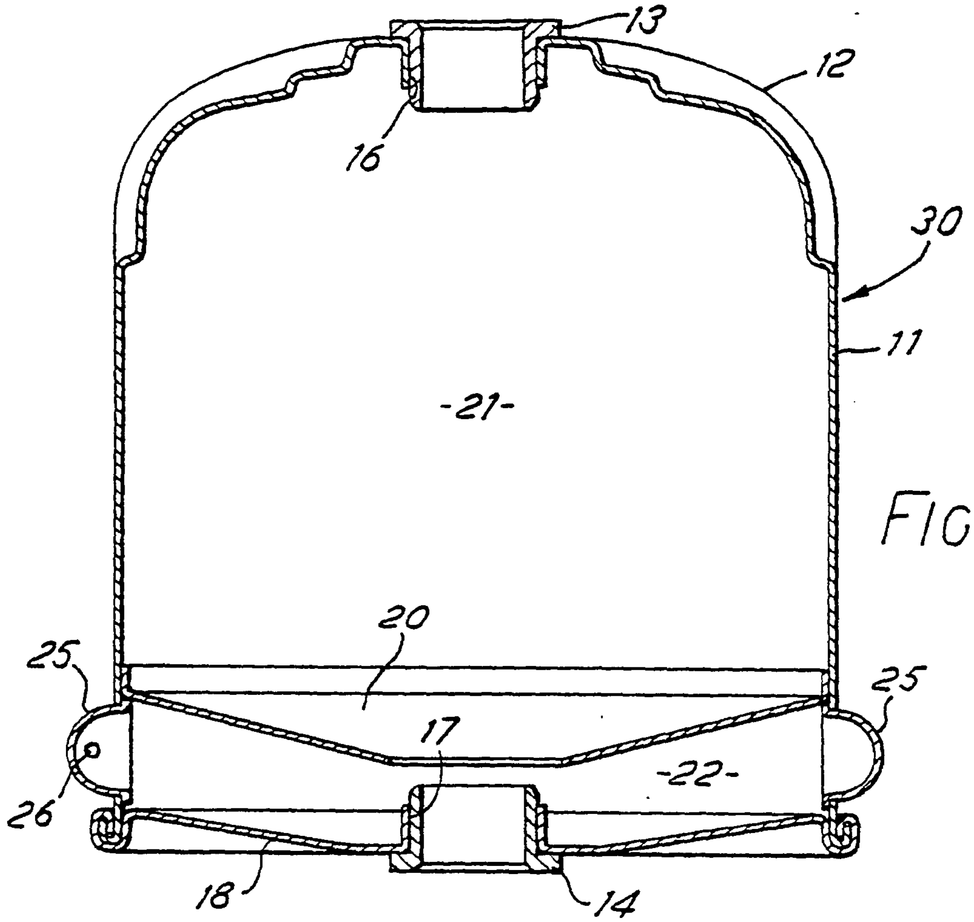

FIG.1

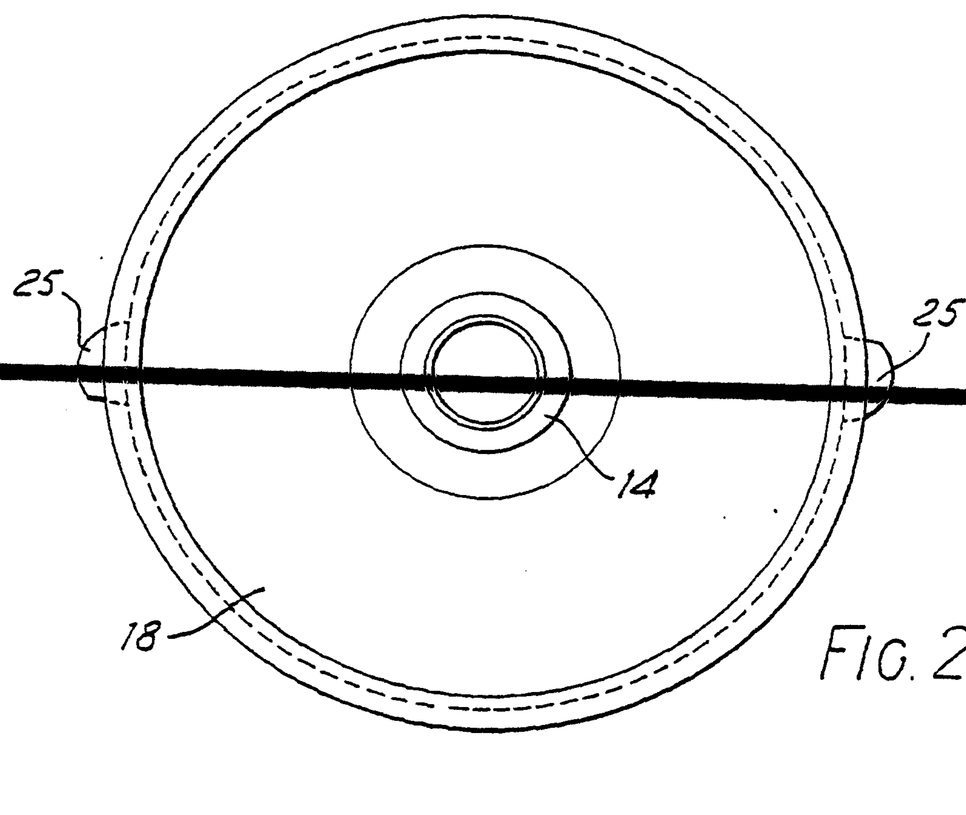

FIG.2

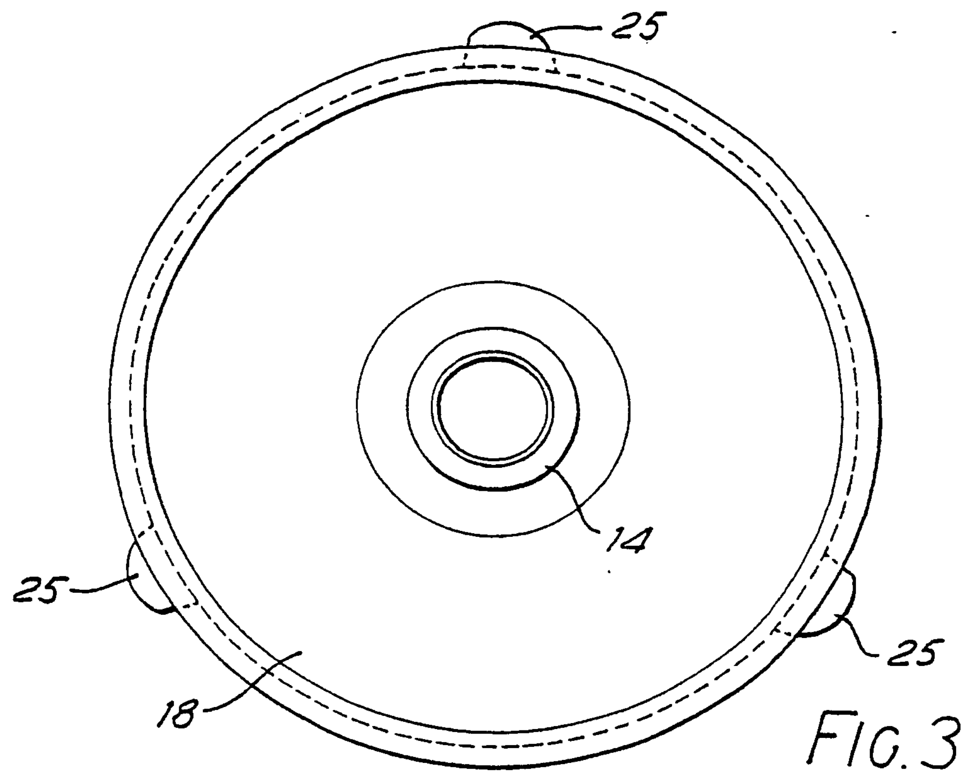

FIG. 3

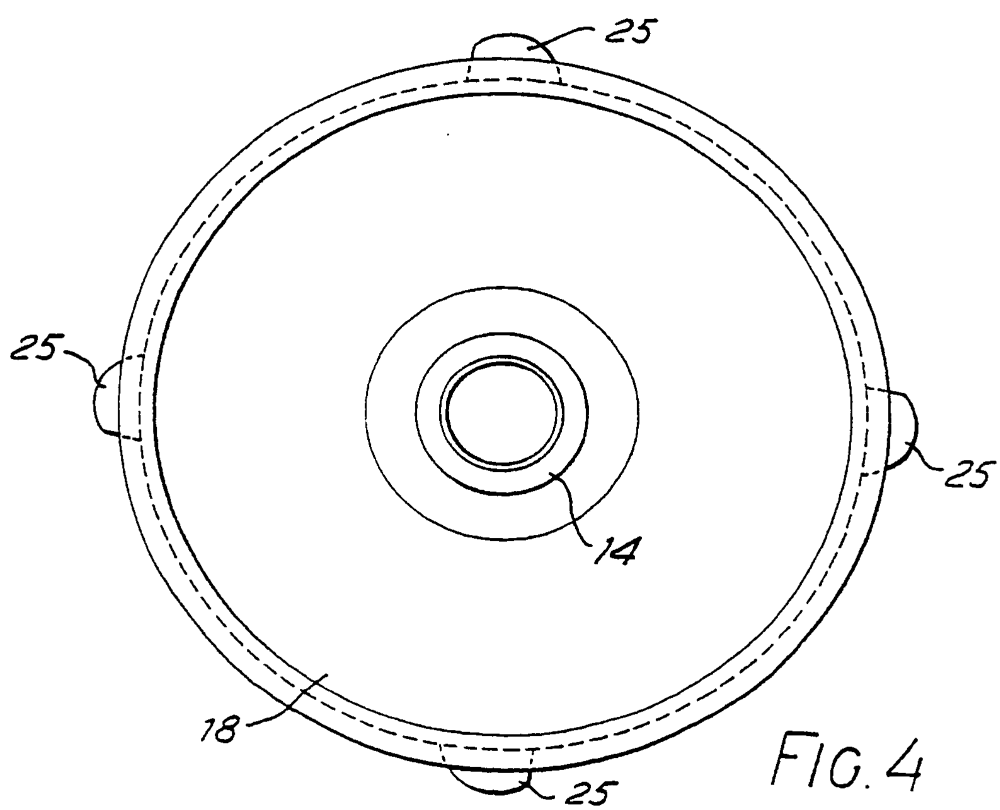

FIG. 4

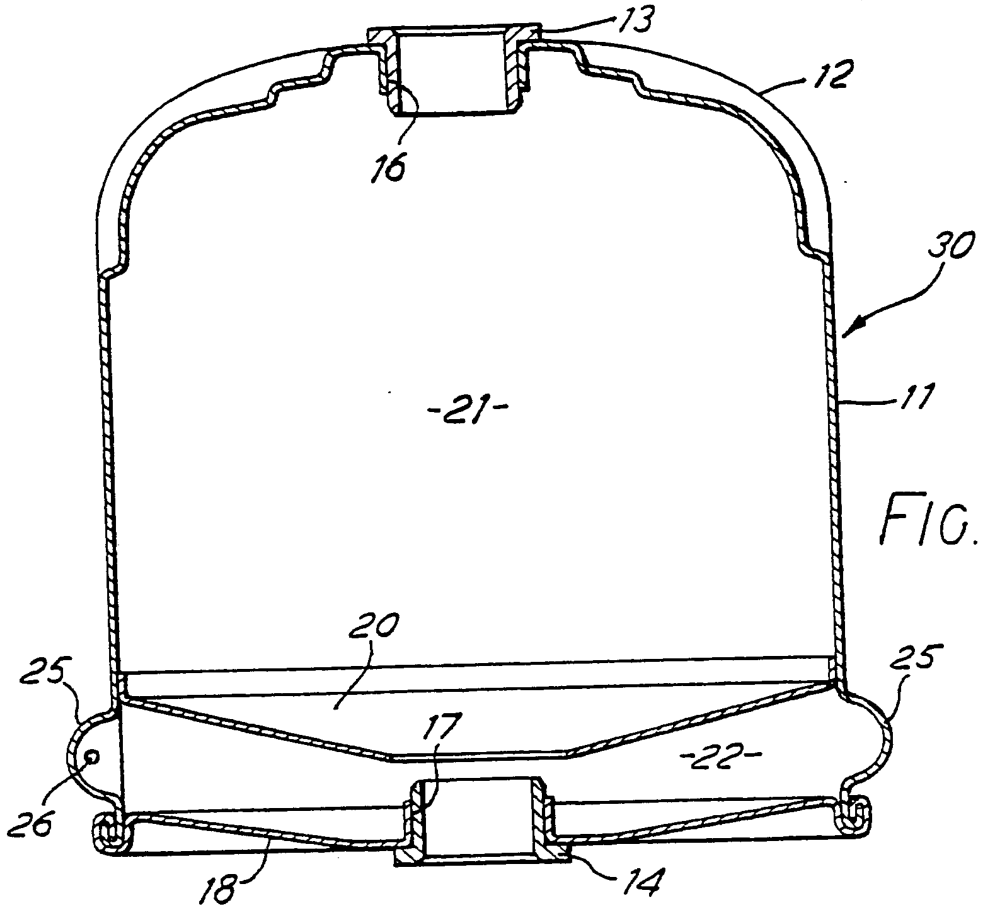

FIG. 5

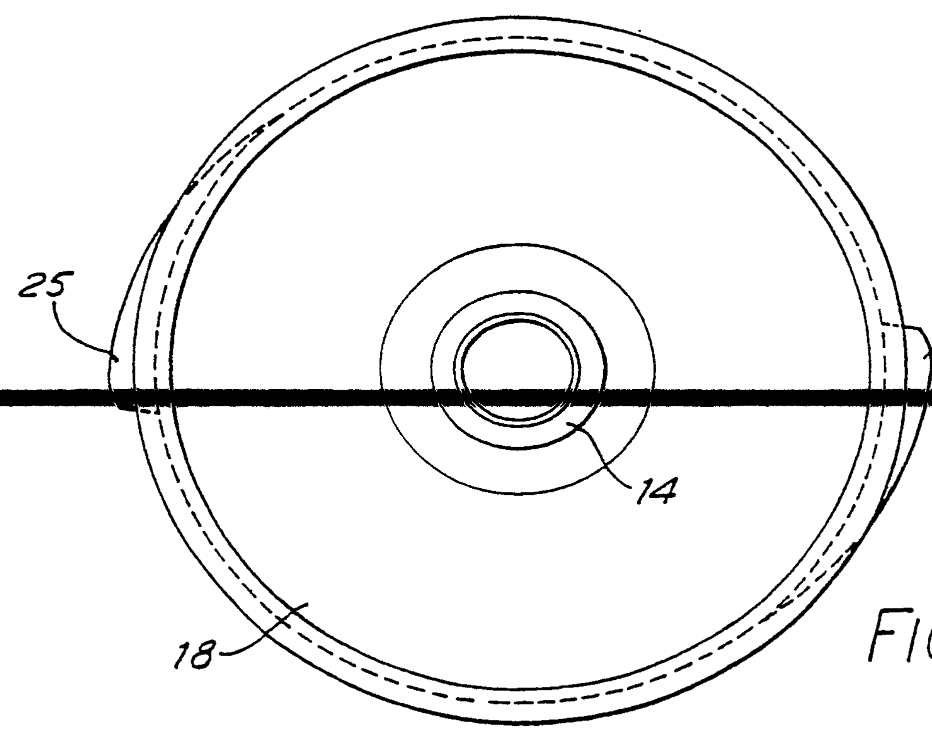

FIG. 6

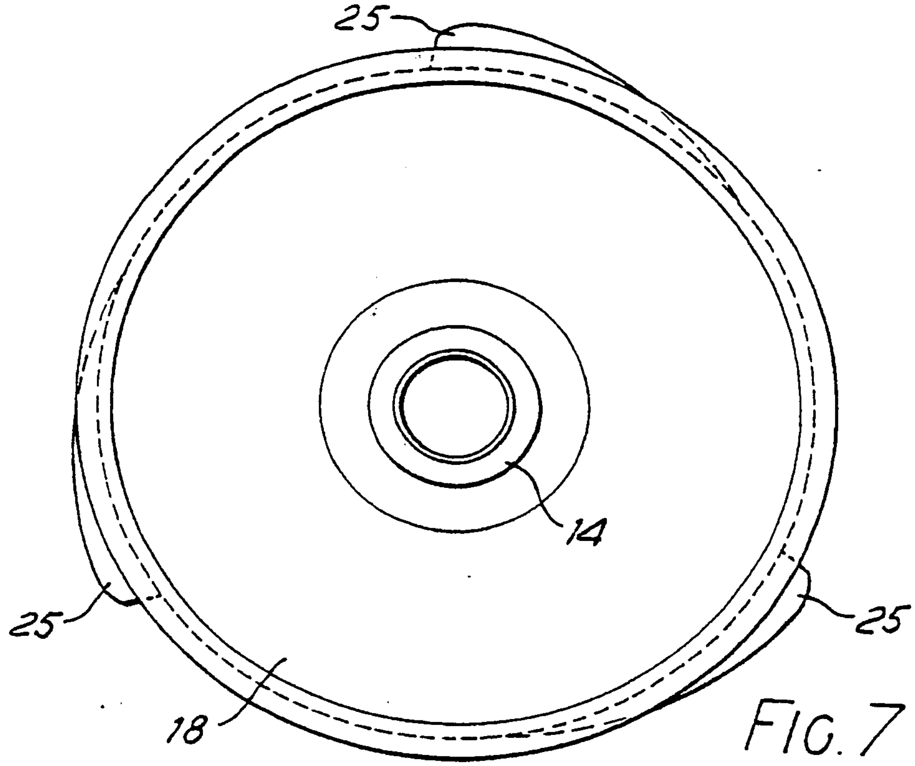

FIG. 7

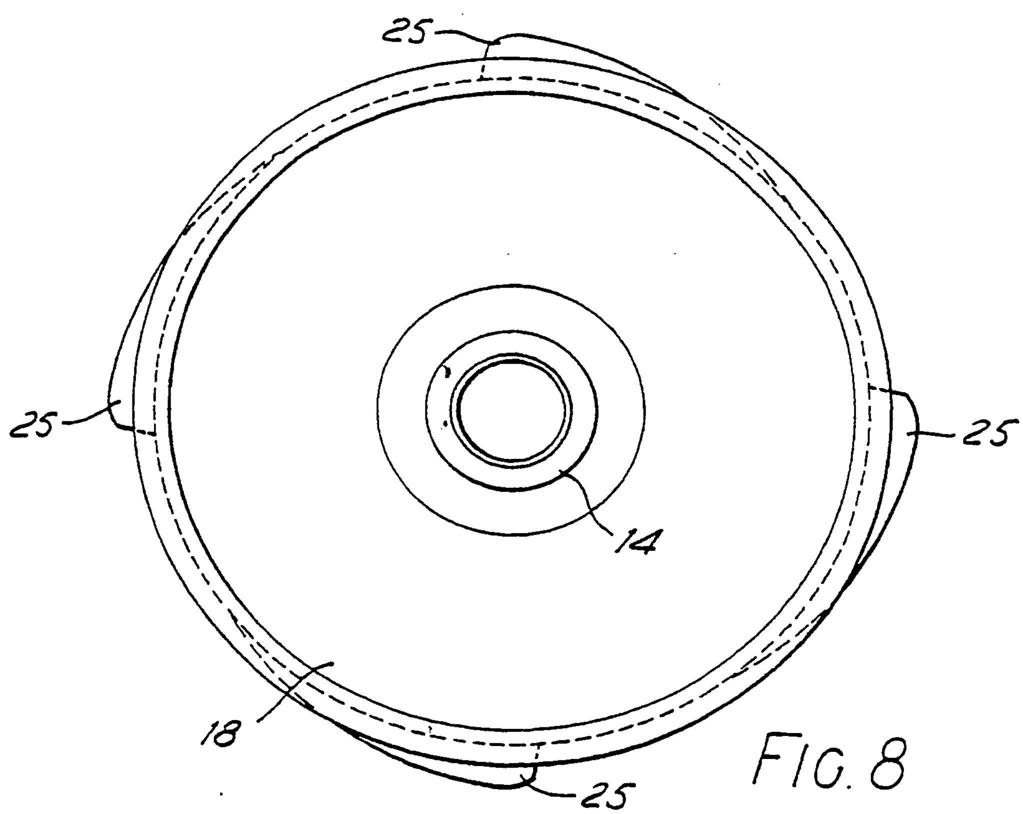

FIG. 8

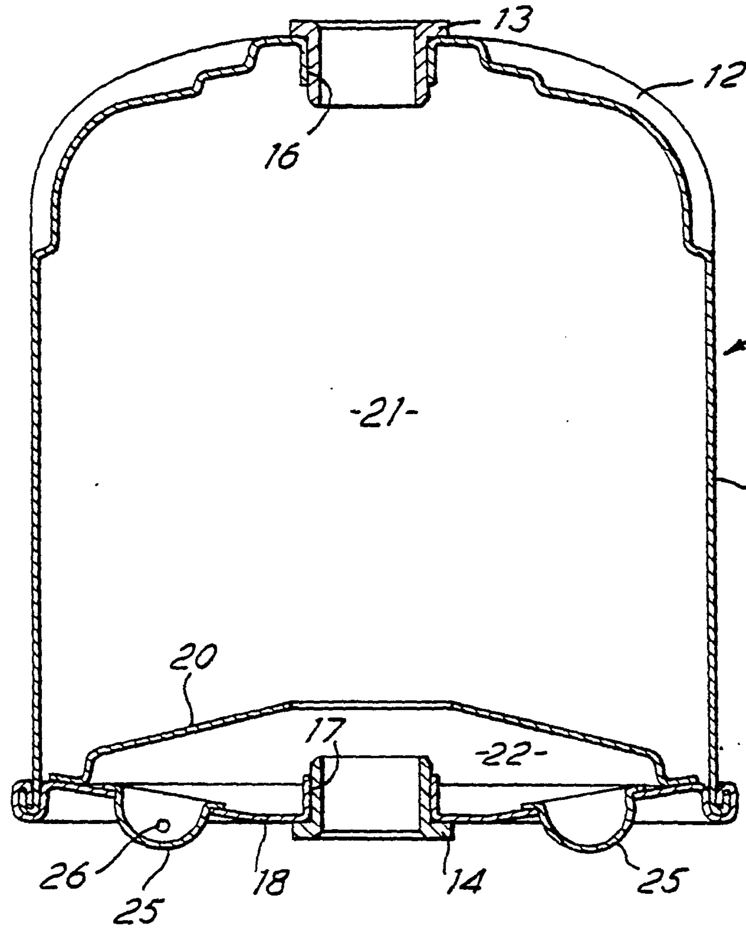

FIG. 9

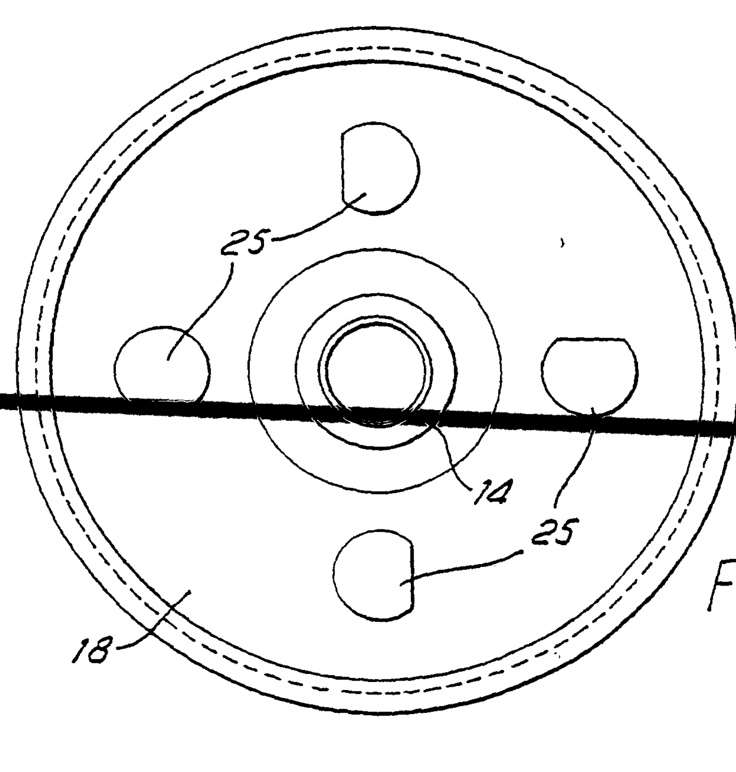

FIG. 10

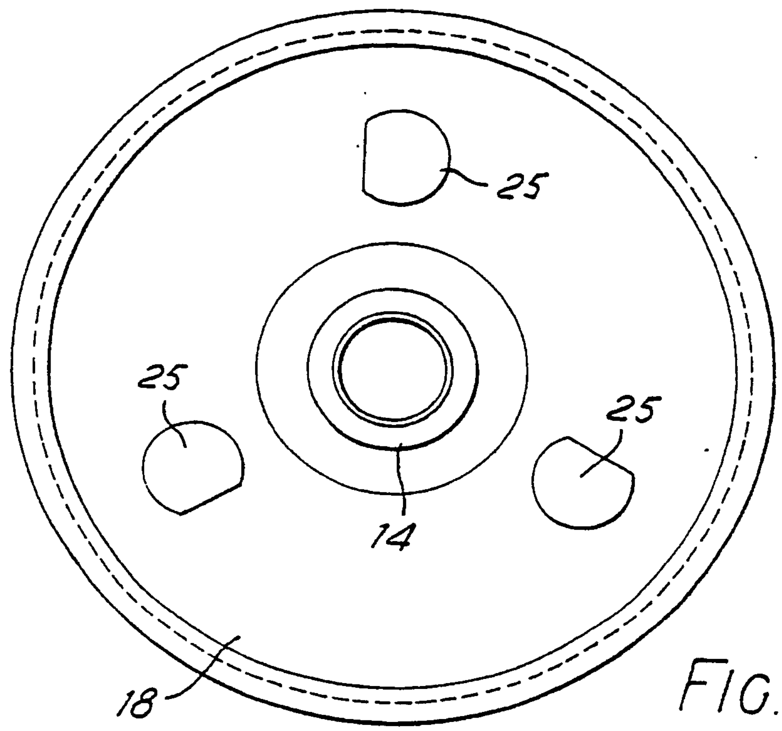

FIG.11

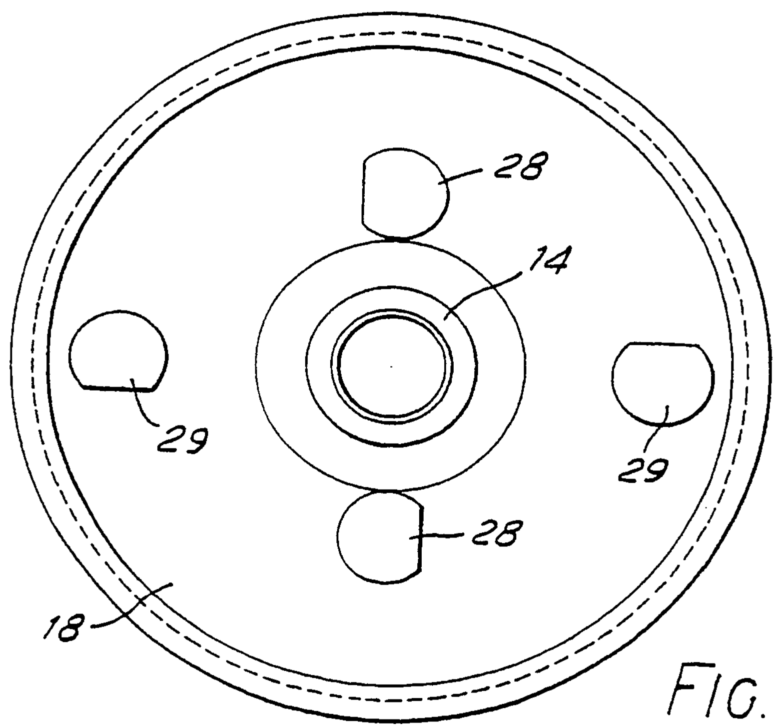

FIG.12

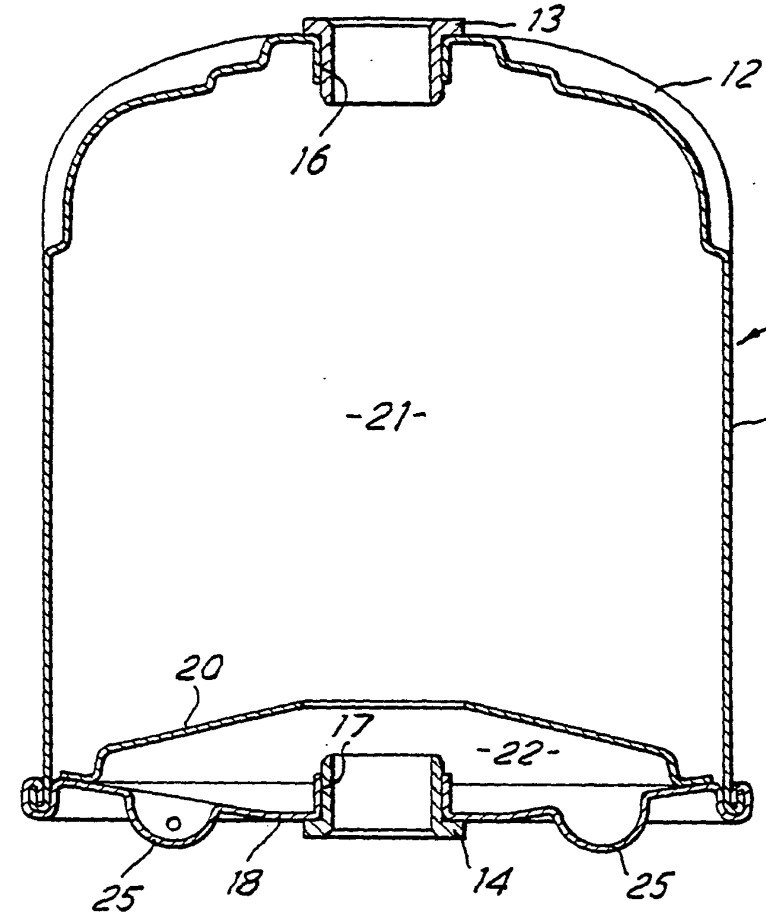

FIG.13

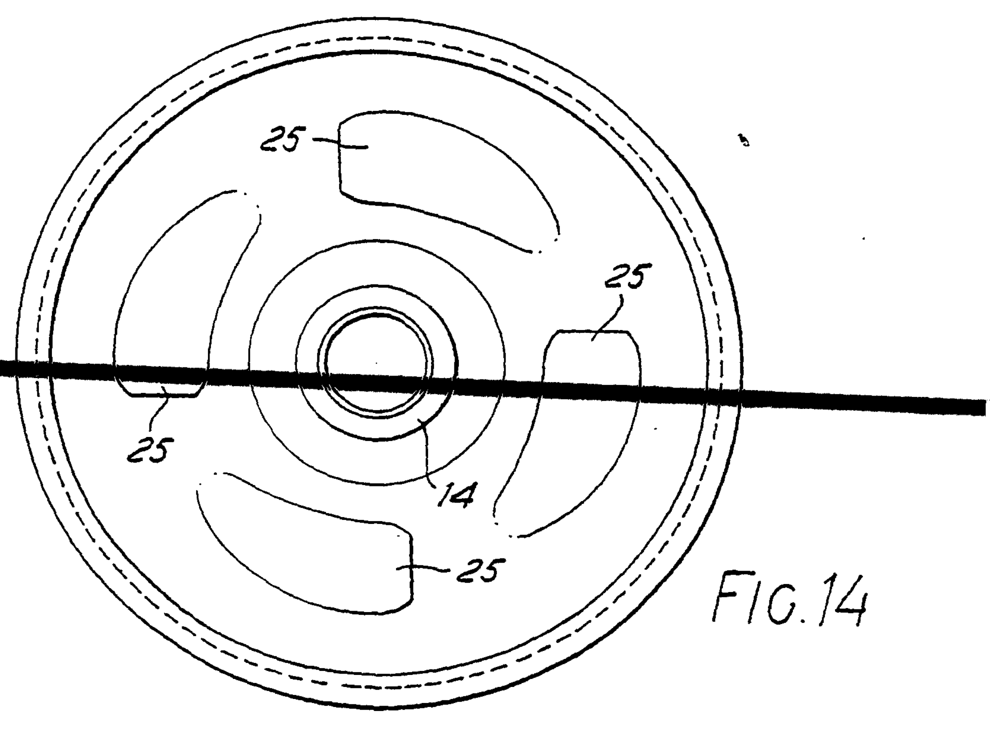

FIG.14

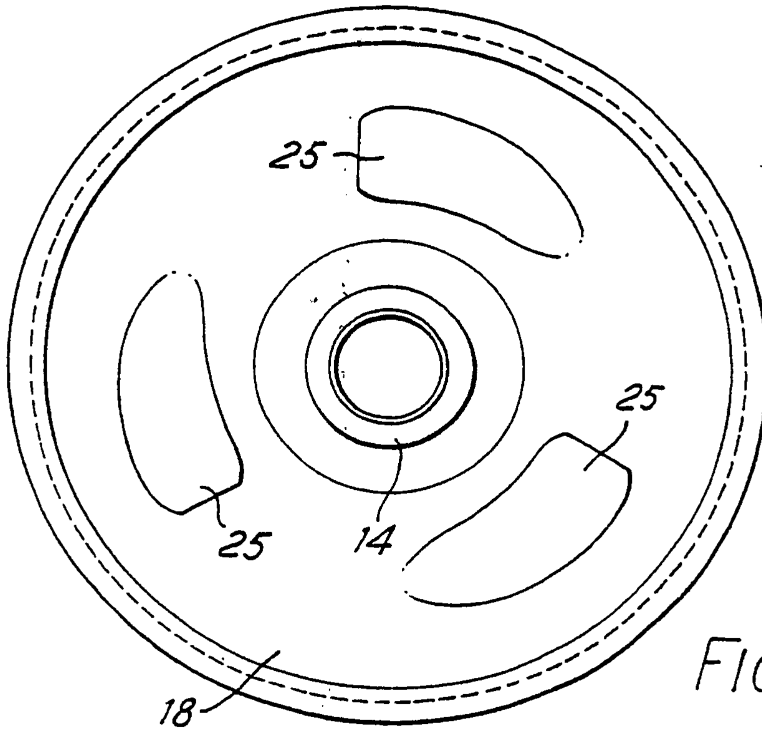

FIG. 15

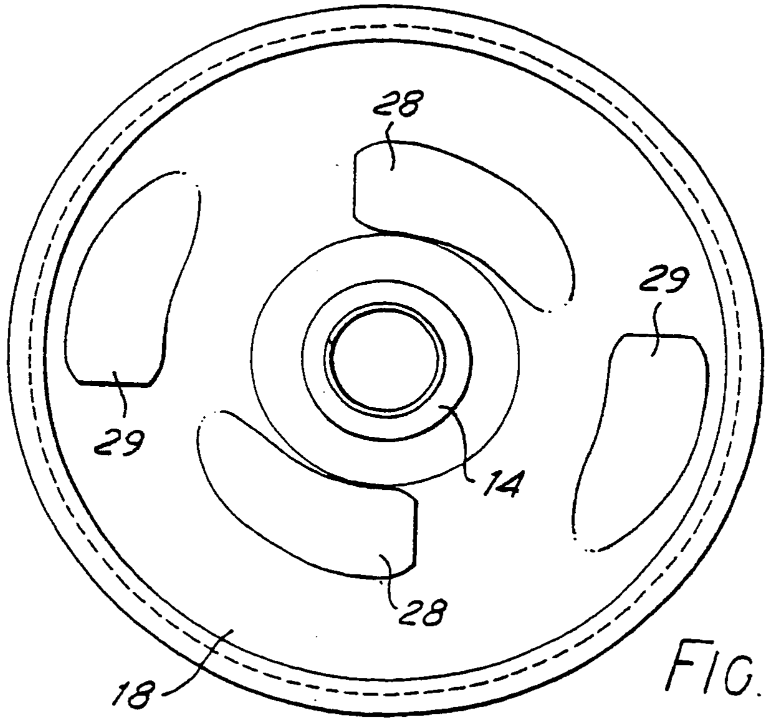

FIG. 16

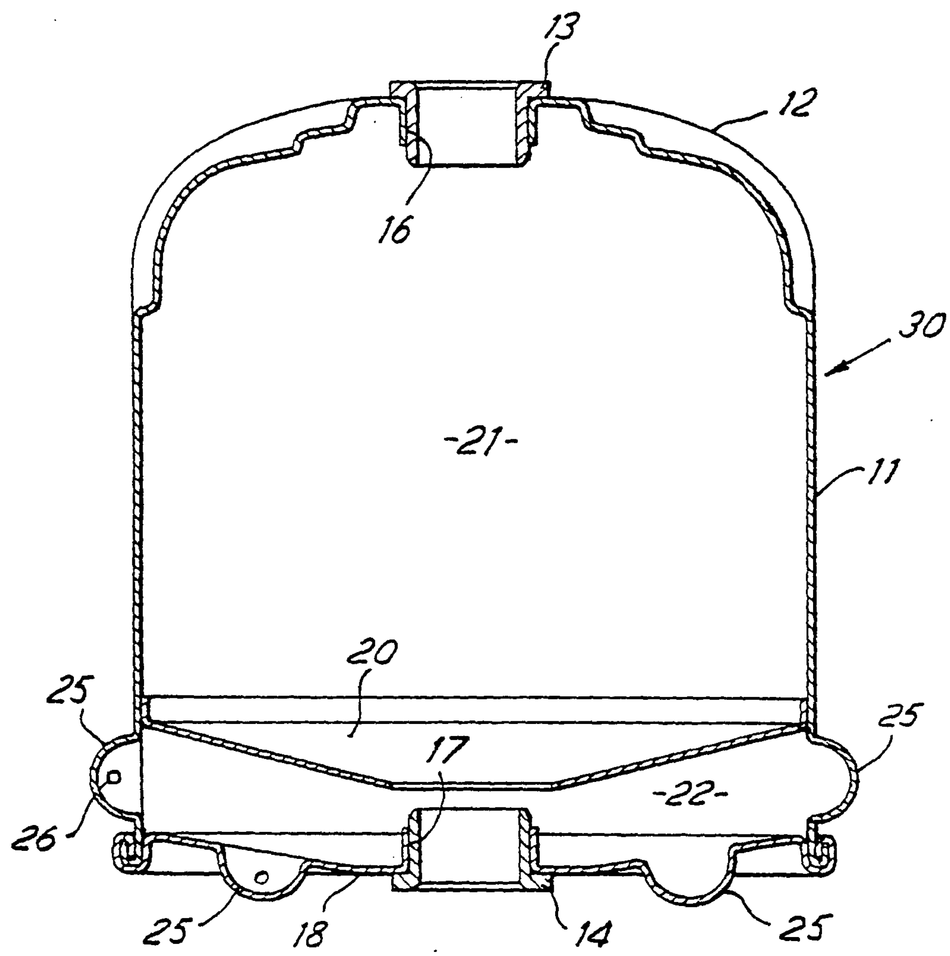

FIG 17

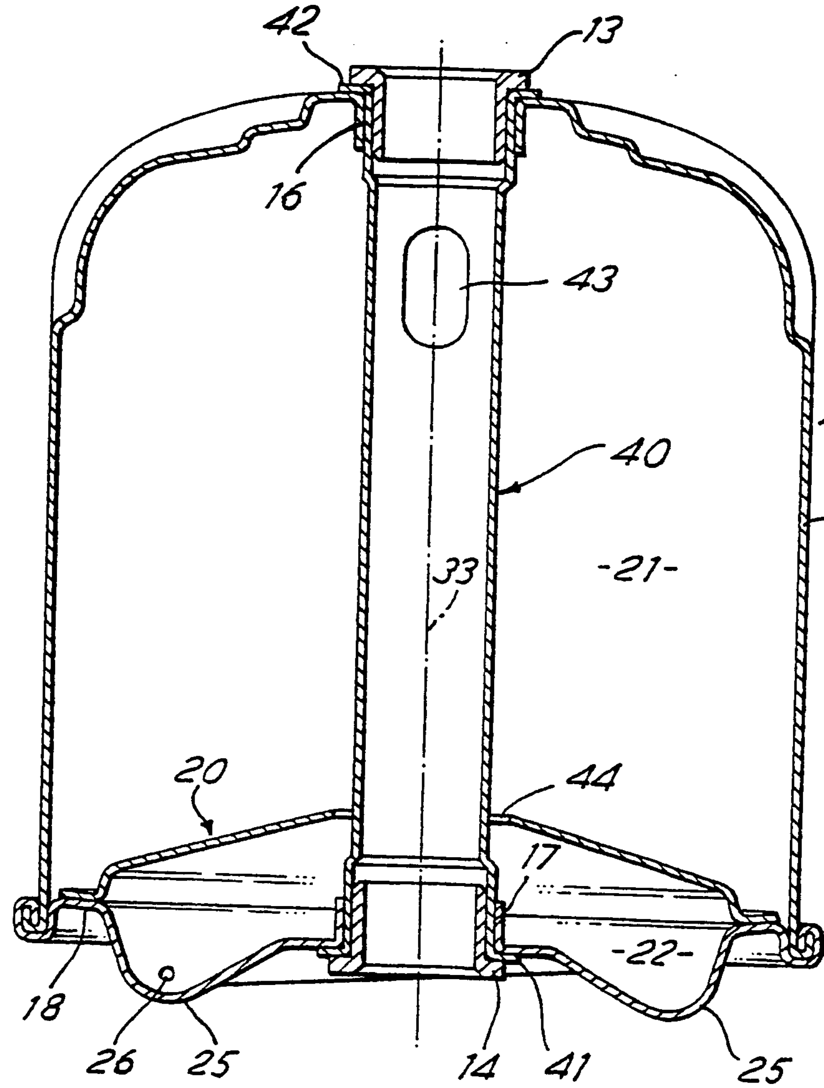

FIG. 18

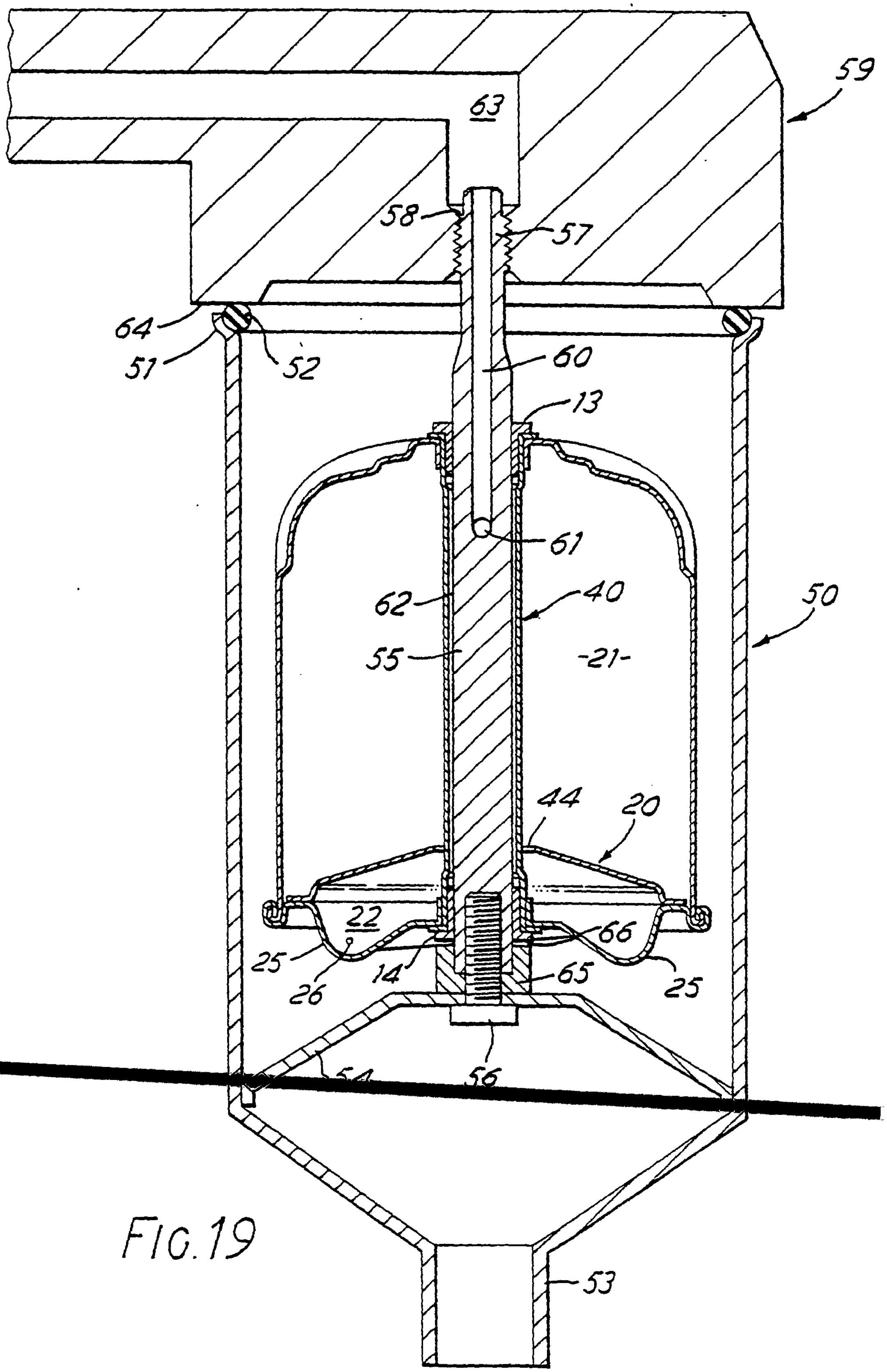
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FIG.19